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Part 9

**OPERATIONAL IMPROVEMENT MEMORANDUM  
PART IX**

**K-25 AND K-27 VENTILATION IMPROVEMENTS**

**AUTHOR:**

**D. A. Burbank**

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Oak Ridge K-25 Site

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**DIVISION OF UNION CARBIDE CORPORATION**

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Date of Issue: April 29, 1960

Report Number: KP-682, Part 9

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CASCADE OPERATIONS DEPARTMENT  
PRODUCTION DIVISION

OPERATIONAL IMPROVEMENT MEMORANDUM, PART IX

K-25 AND K-27 VENTILATION IMPROVEMENTS

D. A. Burbank

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UNION CARBIDE NUCLEAR COMPANY  
Oak Ridge Gaseous Diffusion Plant  
Oak Ridge, Tennessee

Report Number: KP-682, Part 9

Title: K-25 AND K-27 VENTILATION IMPROVEMENTS

Date of Issue: April 29, 1960

Author: D. A. Burbank

A B S T R A C T

This report reviews the studies that preceded the installation of the present K-25 and K-27 ventilation systems, and presents details of that installation, including a cost analysis and an economic comparison between the present and the originally installed systems. In addition, details are given concerning the removal of the original ventilation systems.

## K-25 AND K-27 VENTILATION IMPROVEMENTS

### INTRODUCTION

The ventilation systems in K-25 and K-27 were modified, after extensive testing and study, to effect improved ventilation at substantially reduced power and maintenance costs.

### SUMMARY

Studies conducted during 1956, 1957, and 1958, led to the installation, in 1958, of substantially improved ventilation systems in K-25 and K-27. Tests conducted on the modified system indicate the following improvements:

1. Escape alley ambient temperature reduced 18°F.
2. Average stage motor inlet temperature reduced 6.7°F.
3. The personnel heat stress index in a given escape alley was reduced 46 per cent.

At a total cost of \$407,578, an annual savings of \$217,689 is anticipated, yielding a 1.87-year amortization period. Further, the installation permitted removal of the original ventilation system, thereby, generally reducing fire hazard conditions and eliminating the need for extensive sprinkler installation.

### HISTORY

Over the years, the K-25 and K-27 building temperatures, particularly cell floor ambient temperatures, have been higher than desired. Inadequate cooling, particularly in the escape alleys, prompted maintenance personnel to utilize portable, supplementary ventilation, increasing cell offstream time and maintenance costs. There was also concern over the undesirably high operating temperatures reducing the operating life of the stage motors.

Tests conducted by the ORGDP Medical Department in conjunction with the plant heat stress committee confirmed the problem, and, in fact, indicated there were work areas, especially in the escape alleys of the more heavily loaded units, where the personnel heat stress could approach the recommended plant level for continuous exposure.

### INITIAL STUDIES

Based on the premise that a general lowering of the ambient temperature in the escape alleys was required, several possible solutions to the problem were initially offered. They were:

1. Increased fan speed.
2. Duct and building partition modifications.
3. Increased capacity of the basement intake filters.
4. "Spray-On" insulation of the cell enclosure walls.
5. Relocation of fans and/or redistribution of supply air.

Investigation of the "as operated" system (see figure 1) determined:

1. Modification of the basement intake filters was too expensive, as was insulation of the cell enclosure walls. Painting the cell enclosure walls in K-402-6 was tried as a means of reducing radiant heat effect on personnel but it did not significantly reduce the heat stress index.
2. Some of the operating floor supply air could be diverted to the escape alley without adversely affecting the operating floor cooling but not through the escape alley supply ducts since they were loaded to capacity.
3. This limited duct capacity also prevented profitable increase of the escape alley supply fan speed.
4. Tests run in the K-303 Section, as well as K-402-6, indicated a 28 per cent increase in air supply could be achieved by blanking off the unused over-cell ducts and removing orifices in the escape alley supply ducts.

The key fact revealed during the initial studies of the "as operated" system was that the heat problem was not the result of insufficient air supply, but rather caused by improper distribution of the available supply coupled with the high air velocity at the escape alley supply outlets. The air from the original outlet grilles in the escape alley floor discharged vertically, creating a column effect which pulled hot air down the face of the cell enclosure and down at the center of the alley, thereby, mixing large amounts of hot air from above with the cooler supply air.

Accordingly, the study was directed with more emphasis toward proper distribution of the available air supply.

### SCHEME ONE

By April, 1957, the above initial studies had been completed and the first new distribution scheme had been designed, tested, and work was underway on a second scheme.

Scheme 1 (see figure 2) involved locating new air supply outlet ducts over the original vertically discharging grilles, thereby directing the air supply horizontally in two directions parallel to the cell enclosures and reducing the discharge velocity by approximately 60 per cent. Sixteen of these outlets were fabricated and installed in one of the highest temperature areas, the K-402-6 escape alley.

Tests showed that the Scheme 1 outlets only slightly improved the supply air distribution, due partially to column action where two adjacent, horizontal air streams met, therefore another outlet was designed.

### SCHEME TWO

To correct the above-mentioned column effect, the Scheme 2 outlets (see figure 2) were designed to further reduce the air velocity and to direct the air horizontally in a single direction from the back wall of the escape alley smoothly toward the front. The local "hot spot" at the back of the escape alley was relieved by diverting a portion of the operating floor supply air.

Sixteen of the Scheme 2 supply outlets were fabricated and installed in the K-402-6 escape alley during April and May of 1957, and extensive testing was carried out during the summer of 1957.

By August, 1957, all the Scheme 1 and Scheme 2 testing was completed and recommendations were presented. From the tests, it was concluded that operation of more than 60 per cent to 70 per cent of the originally installed escape alley fans could not be justified, and an optimum ventilation scheme was offered utilizing the Scheme 2 outlets, in conjunction with a reduced number of supply fans in operation.

The recommendations were of only academic interest, however, since, during their formulation, another scheme for cooling the escape alleys was proposed which showed possibilities of even greater savings.

### SCHEME THREE

Scheme 3 proposed removal of the covers from existing escape alley hatches and installation of propeller-type fans in penthouses over these hatches (see figure 2). The installation would change the ventilation from a forced air system to a combination induced and forced draft system.

Test fans were procured to determine the merits of this system, and in September, 1957, eighteen penthouse test fans (9,000 cfm) were installed in K-402-1. Tests were conducted by opening the nine existing 5-foot X 3-1/2-foot hatches in the escape alley floor and locating in each hatchway, two right angle duct turns, each equipped with a 1/2 hp (9,000 cfm) fan.

From the Scheme 3 test, it was determined that 18 hp would be required to deliver the same quantity of air as the originally installed 200 hp capacity. Aside from the \$4,800/year/unit power saving, the motor inlet air temperature was reduced 12° F. to 15° F., and the escape alley ambient temperature was reduced approximately 20° F.

#### SCHEME FOUR

On the basis of the Scheme 3 test, a design was formulated for the installation of six 18,000 cfm, two hp, penthouse test fans in an escape alley of K-27.

The design called for improving the operating floor ventilation also by installing exhaust fans in the operating floor wall to pull cooling air in from the rear operating floor windows and exhaust the hot air at the front of the units.

A review, after installation of the six Scheme 4 penthouse fans (see figure 2) in K-402-6, revealed that the predicted temperature reductions and air distribution improvements were not being met, but after diffuser vanes for the fan outlets were added and three additional fans were installed, the fourth scheme proved very satisfactory. Tests, using 9 fans with diffusers per escape alley, were conducted and the results were:

1. The escape alley ambient temperature was lowered 18° F.
2. The average stage motor inlet temperature was lowered 6.7° F.
3. The personnel heat stress index was reduced 46 per cent.

During the tests, there was an increase in the supply air temperature, therefore, the degree of improvement in the ventilation system was somewhat greater than the above quoted figures.

#### ACTUAL IMPROVEMENT

The results of the testing program indicated very promising improvements were possible in the K-25 and K-27 ventilation systems, consequently, final design was completed and contracts let for installation of the improved systems.

The Scheme 4 penthouse fan (42-inch, 2 hp, 18,000 cfm) with diffuser vanes was adopted. Two hundred ninety-eight of these fans were installed in the escape alley hatchways (some new holes were cut, as optimum fan spacing dictated) in all units in K-27 and in units K-311-1 through K-305-12 in K-25, and the original fan outlet grilles were sealed with sheet metal blanks.

A total of 53 new operating floor exhaust fans (72-inch,  $7\frac{1}{2}$  hp, 55,900 cfm) were installed in the front wall of each of the above units and all the operating floor grilles, as well as the openings in the coolant pit walls, were sealed with sheet metal panels.

Withdrawal alley ventilation in K-25 was provided by the relocation of 47 of the obsolete operating floor fans. These Buffalo Forge blowers, complete with 10 hp motors, were removed from the basements of the K-303 section and installed at the back of the withdrawal alleys in each of the affected K-25 units, and the necessary duct work was provided to obtain supply air from the basements. Similar withdrawal alley ventilation was provided in K-27 by utilizing an additional ten obsolete operating floor fans and providing the necessary withdrawal alley supply ducts from these basement-located fans.

The testing program and the above improvements were accomplished with the expenditure of \$407,578 (see table 1) and annual savings of \$217,689 are anticipated (see table 2); thus, the K-27 and K-25 ventilation improvement will be amortized in 1.87 years. If the power saved by these improvements were evaluated in terms of its application to cascade productive use, the net savings to the company are significantly greater.

The results of the improvement are:

1. Ventilation system maintenance costs reduced by 83 per cent.
2. Power requirements reduced by 80 per cent.
3. Plant fire hazards reduced by removal of the original oil-coated ventilation systems.

#### REDUCED FIRE HAZARD

It should be noted that, although not actually part of the improvement, the removal of the old, originally installed ventilation fans, and their associated duct work was made possible by the installation of the improved ventilation system. This work constituted the elimination of a serious fire hazard as evidenced by the potentially serious duct fire that occurred on October 2, 1957, in the K-311-1 basement.

The removal of the obsolete ventilation systems in K-25 and K-27 was accomplished at a cost of \$129,516 (see table 3). This work simplified the sprinkler system piping and reduced the number of heads required to the extent that a savings of approximately \$132,000 was effected.

Six hundred seventy-three operating floor and escape alley supply fans and motors and the 571 associated fan breakers (25 to 50 amperes) were removed. The fans varied in capacity from 17,000 cfm to 30,000 cfm, and the motors were rated at from 7.5 hp to 20 hp.

In addition, all the duct work that comprised the original ventilation supply system was no longer necessary and a total of 136,000 linear feet of duct was removed, ranging in size from 1'6" X 2' to 2'6" X 5'. In conjunction with this duct removal, 530 openings 1'6" X 4', 530 openings 2' X 3', and 1,060 openings 6" X 3' were sealed with steel plates where the duct risers passed through the cell and operating floors.

The reduced fire hazard and improved appearance and housekeeping conditions are of intangible value to which no monetary value can be assigned; but real value can be assigned to the reduced cost of the sprinkler system installation (see table 3) and the improvement of the K-25 and K-27 ventilation systems can be credited with an additional \$2,484 net savings.

TABLE 1

<u>COST INCURRED</u>	
Engineering	\$ 24,258
Labor	1,961
Material	17,982
Plant Expense	<u>14,817</u>
Sub Total	\$ 59,018
Lump Sum Contracts:	
No. 1305	\$272,682
No. 1251	<u>83,710</u>
Sub Total	\$356,392
Cost of Reused Equipment	\$ 7,832
Grand Total Costs	<u><u>\$407,578</u></u>

TABLE 2

SAVINGS ANTICIPATED

1. Maintenance Reductions (Includes Plant Expense; 100% Before; 110% After)

	<u>Before</u>	<u>After</u>	<u>Reduction/Year</u>
K-27	\$ 9,811	\$1,529	\$ 8,282
K-25	<u>25,379</u>	<u>4,423</u>	<u>20,956</u>
Total	\$35,190	\$5,952	\$29,238

2. Power Reductions (Based on \$33/hp/Year)

	<u>Before</u>	<u>After</u>	<u>Reduction/Year</u>
K-27	\$ 60,134	\$12,441	\$ 47,693
K-25	<u>174,979</u>	<u>34,221</u>	<u>140,758</u>
Total	\$235,113	\$46,662	\$188,451
Savings, Grand Total			<u>\$217,689/Year</u>

TABLE 3

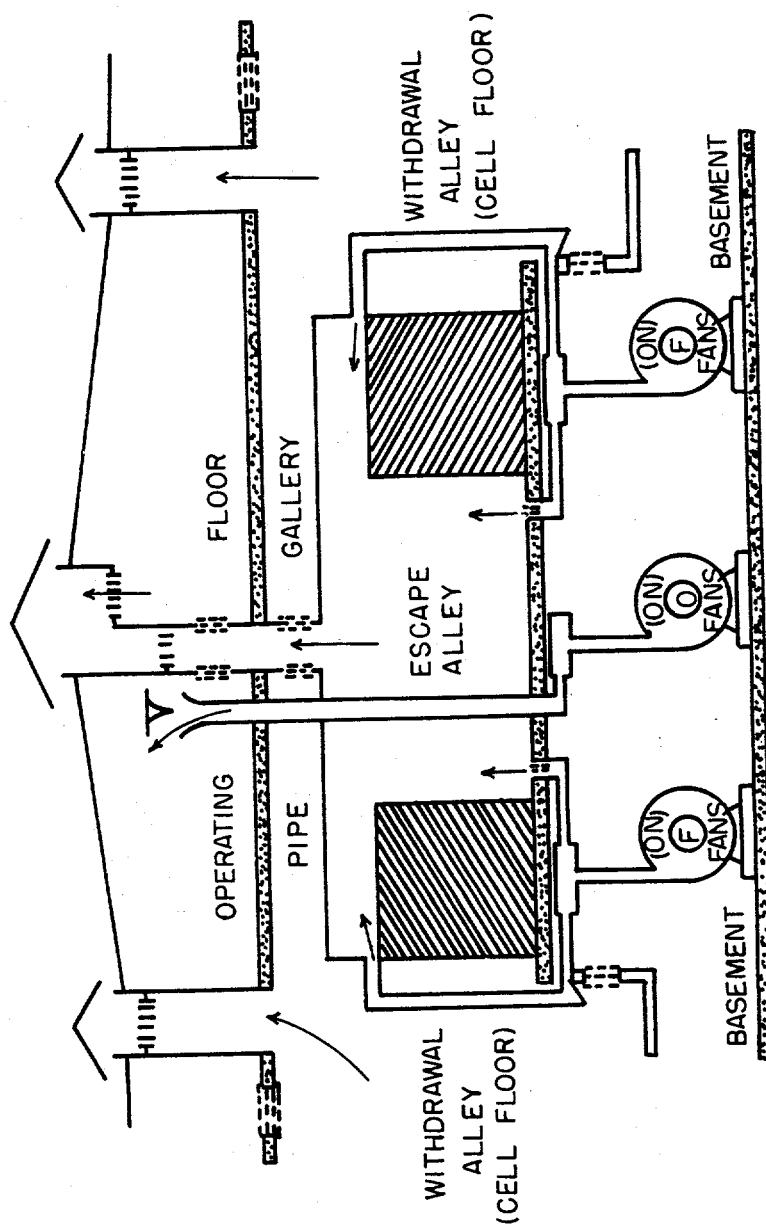
FIRE HAZARD REDUCTION

<u>Cost Incurred</u>	
Engineering	\$ 6,506
Labor	702
Material	52,749
Plant Expense	<u>1,804</u>
Sub Total	\$ 61,761
Lump Sum Sub-Contract (UCNC 423)*	<u>\$120,155</u>
Sub Total	\$181,916
Salvage Credit	<u>\$ 52,400</u>
Total Removal Cost	\$129,516

\*UCNC payments amounted actually to \$112,335 with \$7,820 being retained to cover UCNC's expense of repairing and replacing certain properties damaged during the removal operation.

<u>Savings</u>	
Reduced Sprinkler System Installation Cost	\$132,000
Net Gain	\$ 2,484

K-25 AND K-27 ORIGINAL VENTILATION SYSTEM  
FIGURE 1



K-25, K-27 TYPE ESCAPE ALLEY  
FIGURE 2

